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Plants for America

Great changes are astir in horticulture. These changes are reflected not only in plants and techniques, but also in style and philosophy, their momentum fueled by the demands of modern life and public concern about environmental quality. Particularly noteworthy is the steady if largely unheralded progress of the bedding plant industry. As the prodigious producer of garden treasures for outdoor beds and borders, the industry has over the past 25 years achieved a yearly growth rate of 10 percent. Its 1973 output reached as estimated value at nursery and greenhouse of $150 million.

Why the popularity of bedding plants? Mainly their versatility. Flats of "instant-color" annuals satisfy the needs of impatient gardeners, new homeowners, gardeners seeking a fresh look late in the season, even hosts eager to brighten their grounds for outdoor parties. In these informal times, there is also a trend to gardens that blend flowers with vegetables, another bedding plant industry staple.

Industry advances rest on those of horticultural science. Following World War II, growers turned to F_1 hybrid seed that breeders developed for producing plants with superior vigor and uniformity of color, size, and growth habit. In succession followed the development of packs holding individual plants, artificial growing mixes in response to dwindling supplies of topsoil, and complete water-soluble fertilizers to replace unavailable manure and, more important, feed plants precisely measured nutrients. More recently, scientists have developed many growth regulating chemicals that enable growers to time and tailor all aspects of plant growth. With their advent, leggy and out-of-control plants belong to the past. Today's bedding plants are more compact, greener of foliage, richer in colors and blossoms, and better able to withstand the polluted air of inhospitable urban habitats.

More changes are in the offing. Although the bedding plant industry employs some assembly line methods, its production volume calls for automation. Research is underway, for example, on designing equipment that can direct seed or automatically transplant seed or seedlings in flats. Scientists are also working on encapsulating water and nutrients as one of several approaches to maintaining freshness while plants are in marketing channels.

Bedding plants hold a vital place in America's gardening boom. In the hands of millions of gardeners they will be shaped into mosaics of beauty, enhancing the livability of the humblest plot of earth, and serving as bastions of tranquility against the stresses of life.

***Editor:** R. P. Kaniuka*
***Editorial Assistant:** M. J. Phillips*

Contributors to this issue:
R. C. Bjork, M. C. Guilford,
G. B. Hardin, W. W. Martin,
R. G. Pierce, D. H. Senft

COVER: ARS scientists are deeply involved in research aimed at increasing soybean yields. One of these research efforts is a hydroponics system which permits precise measurement of nitrogen available to the plant, and the amount of residual nitrogen in solution at various stages of growth. Here, Dr. Harper examines a plant to observe the effect of nitrogen fertilizer on nodule formation in the root system (0973X1456–5). See story on p. 6.

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Earl L. Butz, Secretary
U. S. Department of Agriculture

Talcott W. Edminster, Administrator
Agricultural Research Service

Extracting aromas with CO_2

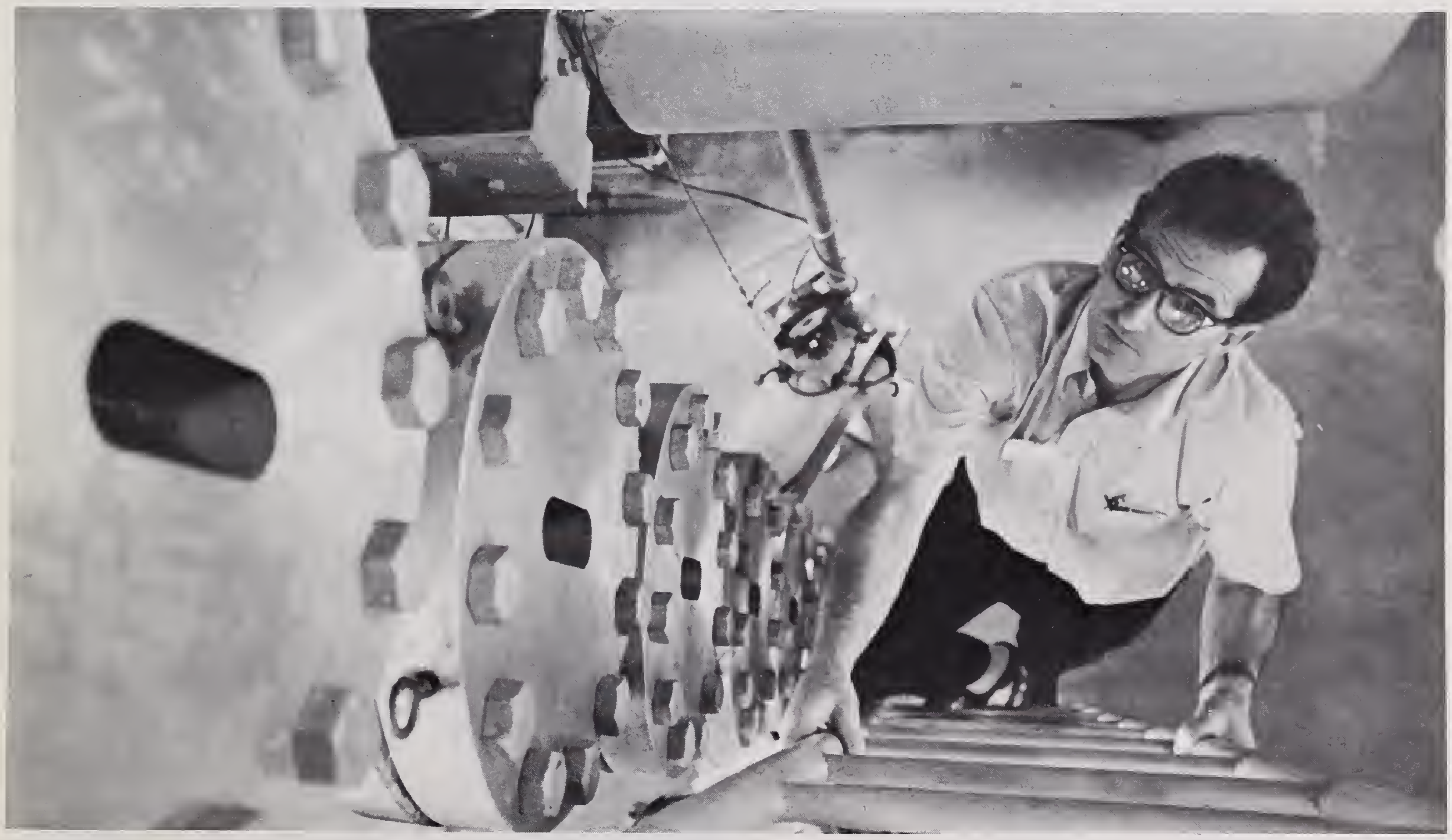
An aroma extraction method now under study may someday provide processed foods and beverages with better and more natural flavor.

Extracting flavors is an old process dating back at least to the Egyptian era. Today's extraction techniques use solvents, such as hexane, to dissolve aromas. It is sometimes extremely difficult to completely remove these solvents, some of which are toxic, from the finished product. These processes also require high heat which can cause the aroma constituents to be changed.

With a process being developed at the Western Regional Research Center, Berkeley, Calif., ARS scientists have separated aroma compounds using liquid carbon dioxide (CO_2) as a solvent. This separation process is simple in principle—dissolve the aroma compounds in liquid CO_2 under pressure, and then evaporate the CO_2 to leave an extract of concentrated aroma constituents. Separation is complete and no damage is done because the gas is nontoxic and does not cause off flavors.

This process hinges on the very selective solvent properties of liquid CO_2. Aroma constituents are soluble, but the sugar, fruit acids, proteins, and water are virtually insoluble. While all this sounds easy, the equipment and operating details are critical. Considerable theoretical work and experimentation are required to reach commercial

The two-story high pressure vessel which surrounds the liquid aroma extractor has ports that enable researchers to view the extraction process. Engineer William Shultz scales a ladder at the pilot plant to inspect the progress of an experiment (0673X427–1).



production. Carbon dioxide is ideal for this extraction because it dissolves aldehydes, esters, and other chemical classes in which most of the flavor substances are found. For example, liquid CO_2 does an excellent job of aroma recovery on orange essence even though the aroma is extremely complex and composed of many different compounds.

The pilot plant at the Research Center operates at approximately 925 pounds per square inch pressure (about 64 times normal atmospheric pressure). Since the plant operates at room temperature there is no aroma alteration caused by temperatures normally associated with distillation.

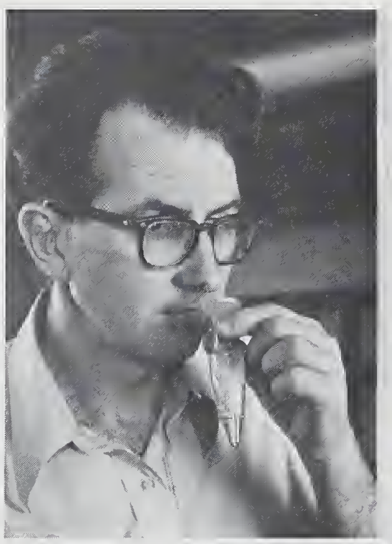
Two separate units make up the pilot plant: a solids leacher to remove aroma compounds from solids, and a liquid extractor to remove aromas from juices or water solutions. Solids, such as apples, oranges and other fruits, soy meal, spices, or fish, are placed in the leaching bed and liquid CO_2 is circulated through them, dissolving the aromas. The extract is collected when the liquid CO_2 is evaporated from this mixture. The CO_2 is stripped from the aroma extract at the evaporation stage, recondensed, and recycled continuously back through the leacher.

The second unit, the liquid extractor, is a counter-current, 10-stage column. Here, the aroma-bearing liquid flows downward and is progressively stripped of aromas at each stage, finally emerging at the bottom with all aroma removed. The CO_2 flows upward in the same column picking up more and more aroma at each of the 10 stages. After the 10th stage, the aroma-CO_2 solution is removed and then transferred to an evaporator, where the CO_2 is stripped off. This CO_2 is recondensed and recirculated continuously back through the extraction column.

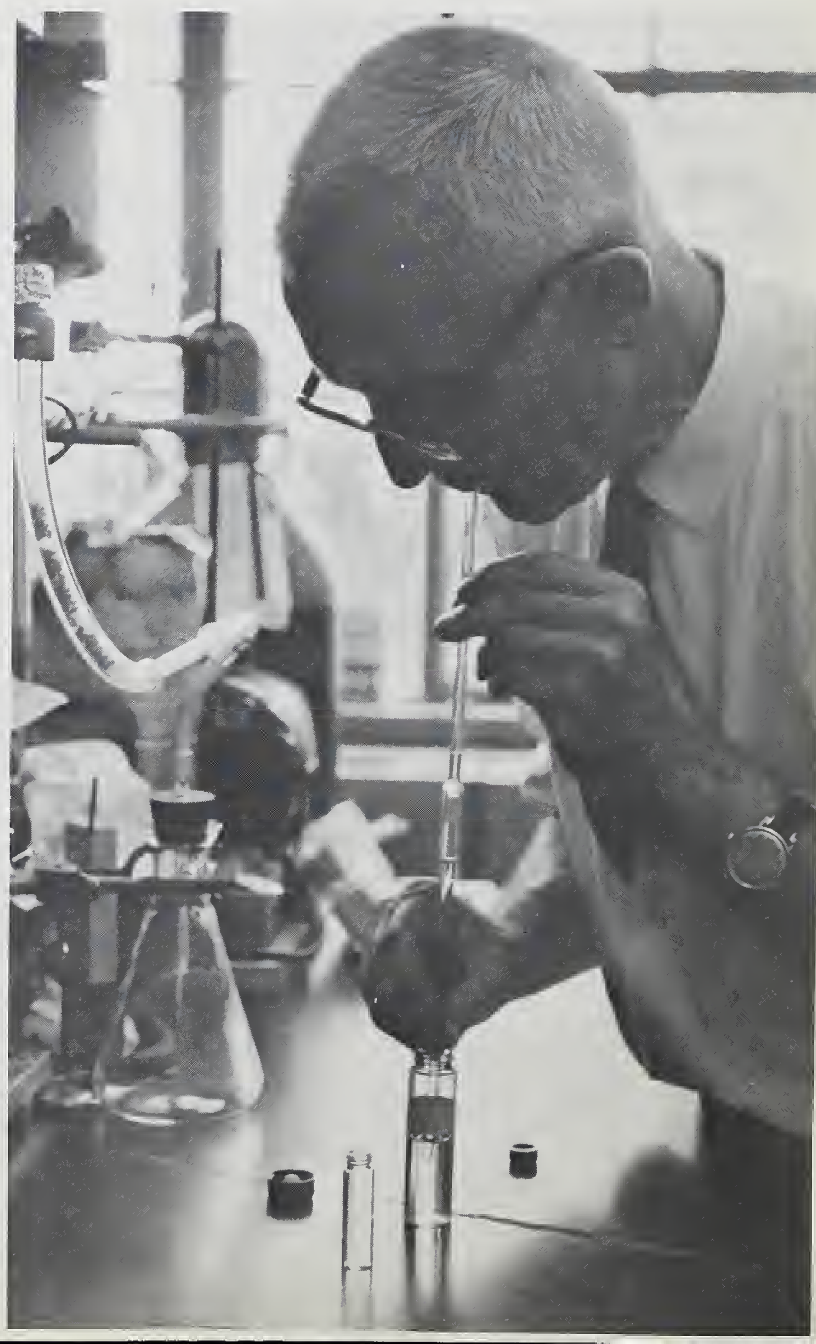
Natural fruit has a concentration of aromas that is approximately 50 parts per million or about 3 tablespoons of actual aroma constituents per ton of fruit. Almost all of this aroma concentration can be recovered with CO_2 extraction.

Researchers report that the liquid CO_2 process can also extract aromas from spices. Spices, often high in bacteria counts, must be cleaned or sterilized before they can be added to foods. Sterilizing often causes a chemical reaction which alters the aromas. With CO_2 extraction, however, the essence would be unaffected and, at the same time, be produced with a uniform concentration—very important in maintaining product uniformity.

Scientists working on the process at the Center include: engineers William Schultz and Robert Carlson, chemist Thomas Schultz, and technician Joyce Hudson. □



Above: Extract aroma gets an informal check by Mr. Shultz prior to chemical analysis (0573X428-8). ***Right:*** *Dr. Thomas Shultz (no relation to William Shultz) prepares sample of aroma extract for evaluation through gas chromotography (0573X428-23).*



Nickel: an essential trace element

NICKEL plays an essential physiological role in some laboratory animals.

Studies in which livers of chicks and rats were adversely affected by diets extremely low in nickel were conducted by ARS and University or North Dakota scientists as a preliminary step toward investigations of the possible role of nickel in human nutrition. These studies will complement other ARS studies concerned with the availability of trace elements in the food chain—soil to plants to animals and humans. Biochemist Forrest H. Nielsen, ARS Human Nutrition Laboratory, Grand Forks, N. Dak., led the studies.

Nickel is fairly abundant and widely present in nature. Further research may show that requirements for it are of greatest importance when there are nutritional diseases caused by diets inadequate in other nutrients.

Only meager insights have been gained as to nickel's metabolic function. The major effects of nickel deficiency observed thus far have been found principally in the liver of chicks and rats.

The liver, besides secreting bile into the intestine to aid digestion, performs other important functions. This body organ is involved in the breaking down of protoplasm to provide energy for life processes. It is also involved in building up protoplasm from carbohydrates and proteins.

Dr. Nielsen and his colleague, Dwayne Ollerich, professor of anatomy at the University of North Dakota, Grand Forks, examined livers from nickel-deprived chicks with an electron microscope and found extensive degeneration of the physical organization of the protoplasm. Dr. Nielsen consistently observed gross differences—without a microscope—between livers from experimental and control animals. Nickel-deficient chicks' livers were less crumbly, and nickel-deficient rats' livers had a muddy brown color compared to a red-brown color of livers from their normal counterparts.

Another abnormality observed was the decreased oxygen uptake by homogenates (finely ground biological tissue) of laboratory animal livers in the presence of alpha-glycerophosphate. This finding provides a biochemical indicator of metabolic activity. Day-old chicks, fed for 3½ weeks on a nickel-deficient diet, also had less pigmentation of the skin of their shanks, the lower parts of their legs.

Diets fed to induce nutritional deficiency contained as little nickel as 3 to 4 parts per billion (ppb). In the research with rats, a low-nickel diet was fed to successive generations to bring out the effects of the deprivation.

Inasmuch as nickel is ubiquitous in nature, Dr. Nielsen obtained feed for the animals only by careful selection of "natural" ingredients—diets prepared of purified proteins, amino acids, carbohydrates, vitamins, and minerals were unsatisfactory because some ingredients contain as much as 20,000 ppb nickel. He made certain that the animals did not get the trace element from such sources as caging, feed cups, water bottles, dust in the air, and skin of the investigators' hands.

If man has a requirement for nickel that can be extrapolated from animal data, Dr. Nielsen said, it is probably in the range of 16 to 23 micrograms per 1,000 calories consumed. Most diets provide this amount. Nickel nourishment of man does not appear to be a practical problem. It is possible, however, to formulate a human diet much lower in nickel than the speculated requirement using fats and foods mostly of animal origin.

For humans, possible practical significance of the finding that nickel is essential in animals is in concern for certain individuals—persons who have diseases that interfere with intestinal absorption, who are under extreme physiological stress, or who have unusual dietary habits. Persons with cirrhosis of the liver or with chronic uremia are known to have low levels of nickel in their body fluids. Dr. Nielsen said that these findings may be indicative of nickel depletion.

Foods of plant origin are abundant in nickel compared to those of animal origin. Grains, especially rich in nickel, are also high in an organic substance called phytin which scientists have found decreases the availability of zinc and possibly other trace minerals for intestinal absorption. It remains to be determined whether organic nickel complexes influence the biological availability of nickel and whether they are the usual compounds of nickel in plant tissues.

Nickel is one of several trace elements found essential for laboratory animals since 1970. Previously, scientists made these discoveries at the rate of about one each decade. Dr. Nielsen credits the recent discoveries to improved experimental technology. The other elements recently identified as essential are vanadium, silicon, and tin, and evidence has mounted concerning fluorine. It is likely that these elements may also be essential for man. □

The Goal:
higher-yielding soybeans

Against a background of modern soybeans, Dr. Bernard examines one of their vine-like wild ancestors. Grown from seed collected in the Orient by Dr. Bernard, these ancient plants may provide new varieties with genetic resistance to disease, insects, and nematodes (0973X1463–10).

THE SOYBEAN INDUSTRY anticipates world markets for 2 billion bushels of beans by 1985, nearly double the present demand.

This unprecedented demand is challenging growers to plant larger acreages of soybeans and to examine present production techniques. To help growers achieve advances in production, scientists at the U.S. Regional Soybean Laboratory, Urbana, Ill., are cooperating on a broad spectrum of research with the Illinois Agricultural Experiment Station. Research at the Laboratory, administered by ARS, constitutes a concentrated team approach to getting answers to the question: How can we step up soybean yields to match increasing world demands?

Nitrogen Utilization One puzzle to be solved is how to improve nitrogen utilization. Plant physiologist James E. Harper says about 400 pounds (lbs) of nitrogen are required to produce a 70 bushel per acre soybean crop. But his research, involving both soil plots and outdoor hydroponic units, shows that neither nitrogen fertilization nor nitrogen-fixing bacteria alone can meet the legume's need for this element at anticipated yield levels. Normally, symbiotic fixation can provide about 100 lbs of nitrogen per acre; however, high levels of nitrate fertilization inhibit fixation.

Accordingly, Dr. Harper is orienting his research toward enhancing the compatibility of the two systems of nitrogen utilization. Soybean plants lose some ability to take up and use

nitrate at the end of the growing season—a condition which favors maintaining symbiotic fixation for higher yields. Perhaps some new form of nitrogen fertilizer may be found that is less inhibitory to symbiotic fixation. An alternative may be to seek strains of nitrogen-fixing bacteria that tolerate high rates of nitrogen fertilization.

Nutrients and Lodging Improving the crop's ability to use nutrients may intensify another barrier to higher yields—lodging. Agronomist Richard L. Cooper, research leader of the Laboratory, found that plants affected by early lodging form fewer soybean seeds than do those which escape lodging.

How lodging affects yield is not fully understood, but evidence points to reduced light-use efficiency. When lodging occurs at early pod set, a highly organized crop canopy is disrupted, causing light to be distributed less uniformly over the total leaf area because of increased mutual shading of leaves. Moreover, the older leaves get more light while many younger, more photosynthetically active leaves become shaded. Dr. Cooper suggests that lodging may also lessen yields by stimulating terminal growth and excessive branching at the expense of seed set. Developing semi-dwarf varieties may provide a solution.

Soybean breeders, taking a cue from wheat and rice breeders, are at work developing semi-dwarf soybeans that will be high-yielding as well as resistant to lodging. In other research, Dr. Cooper is investigating the effectiveness of 7-inch rows and low plant populations in preventing lodging. Adequate weed control will be essential for insuring higher yields with narrow rows.

Weeds and Yields In research on weed ecology, data on soybean yields are being collected from plots where crops and herbicide treatments have been rotated since 1964. This long-term project, funded by ARS under a cooperative agreement with the University of Illinois, is led by weed scientist, Fred W. Slife of the Illinois Agricultural Experiment Station. Scientists are also compiling information on weed yields, weed seed content of the soil, and herbicide residues—plus their effects on nematodes and other small animal life in the soil.

Effect of Sunlight Plant physiologist William L. Ogren, is probing the secrets of photosynthesis in hopes of increasing soybean yields (AGR. RES., Sept. 1971, p. 8). Dr. Ogren points out that soybeans, compared with plants like corn, sorghum and sugarcane, are inefficient users of sunlight. Photosynthesis in the soybean is retarded by a process called photorespiration wherein the plant, in the presence of light and abundant oxygen, breathes out some carbon dioxide (CO_2) that had previously been incorporated in sugars.

Dr. Ogren is trying to develop nonphotorespiring soybean plants by applying radiation and other mutagenic agents to seeds. If he succeeds in modifying the enzyme that triggers the changing of CO_2 into sugars and vice versa, soybean yields could theoreti-

Above: This soybean's terminal bud is determinate in growth habit. Once its flower bud is formed there is no further increase in plant height—hence little tendency to lodge. Dr. Cooper is attempting to develop new semi-dwarf varieties incorporating this characteristic (0973X1459–18). ***Below:*** *An undesirable trait of soybean varieties is indeterminate terminal bud growth. Soybeans with this trait increase in height throughout the growing season, often sustaining severe lodging with reduced yield (0973X1459–17).*

cally increase by as much as 50 percent.

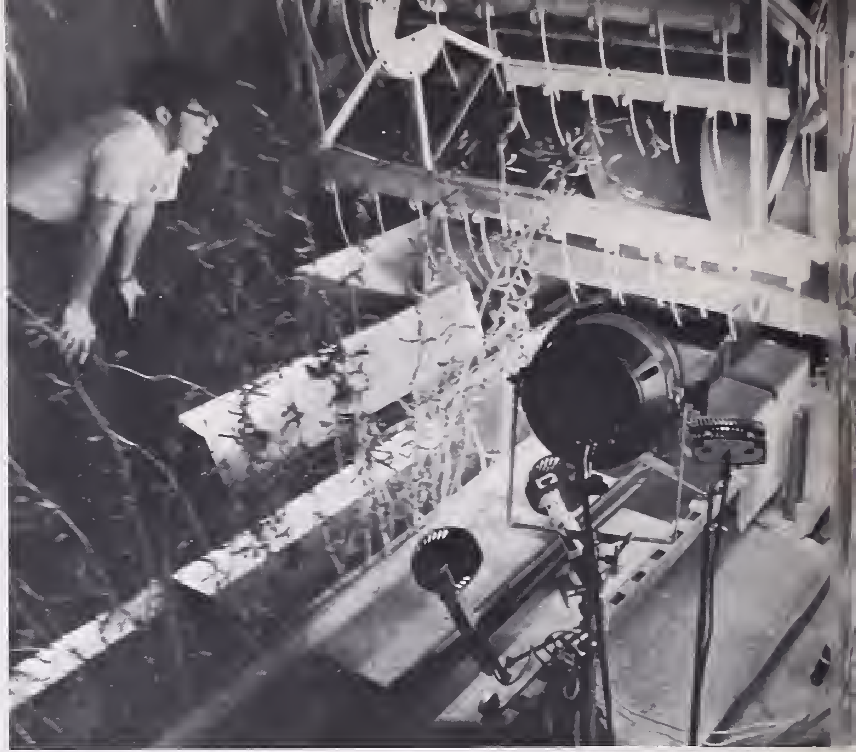
Content of Beans Chemical composition, especially oil and protein content, is an important consideration in the developing new soybean varieties. Chemist Orlang A. Krober supervises the annual analysis of 8,000 to 12,000 seed samples, mostly in support of uniform tests in a soybean breeding program which the U.S. Regional Soybean Laboratory coordinates with several State agricultural experiment stations. He is also developing an experimental infrared reflectance method for detemining protein, oil, and moisture content of soybeans. This method may expand the scope of chemical research in breeding programs and may enable growers to be paid on the basis of quality as determined at the elevator.

Scientists are also paving the way for breeders to develop varieties that produce more oil and protein. One approach centers on the role of basic enzyme systems. Plant physiologist Robert W. Rinne is studying the metabolism of growing soybean plants to trace the biochemical pathways involved in the synthesis of oil and protein.

Disease Control Losses to diseases—which vary from year to year, but average 10 to 12 percent annually—must be reduced. Brown stem rot, an important disease in the Midwest, for example, claims up to 25 percent of yield in some fields. This disease is among several currently studied by plant pathologists Ronald W. Chamberlain and Lynn E. Gray.

Another disease under study is charcoal rot. It significantly cuts yields but often goes unnoticed because plants that seemingly are maturing a few weeks early are actually infected—their seeds fail to develop or the pods fill poorly.

Developing varieties with resistance to several diseases and insects is a goal of plant breeders but necessary germ-



Above: A high-speed motion picture camera records the feeding of soybean stalks into a harvester reel and experimental cutterbar mounted on a laboratory test stand. When analyzed in slow motion, the film record will enable agricultural engineer W. Ralph Nave to determine reasons for harvest losses and, hopefully, lead to better designs for harvesters (0973X1457–9). ***Right:*** *In research probing the secrets of enzymes, Dr. Rinne subjects developing cotyledons to incubation with radio-active compounds to learn more about how developing soybean seeds synthesize protein and oil (093X1485–1).* ***Below:*** *Dr. Bernard fills one of the many requests for germ plasm received from researchers throughout the world. The laboratory's germ plasm collection contains more than 3,000 entries (0973X1460–11).*

plasm has often been lacking. Geneticist Richard L. Bernard, who developed varieties now grown on most of the Midwest's soybean acreage, made a plant exploration trip to Japan and Korea last fall, collecting over 2,000 soybean seed samples, including some from wild species. When these materials are fully catalogued, the Nation's soybean germplasm resources may more than double.

New races of insects and diseases constantly evolve so that the plant breeder's work is never finished. Until some new soybean varieties are developed—a few years hence—soybean cyst nematode (SCN) Race 4 may become the number one limiting factor of soybean production in some places. These nematodes occur in many areas of Missouri, Tennessee, and Arkansas and were found in two places in the southern tip of Illinois in 1972. For the present, nematologist Dale I. Edwards advises: "Crop rotation of soybeans with corn or small grains, maintained free of all weed hosts for at least 3 to 5 years, offers the best control for SNC."

When breeders develop soybean varieties resistant to the new race of SCN, initial supplies of seed will be limited. Dr. Edwards suggests that blending the seed of resistant and susceptible varieties may offer advantages beyond conserving the new seed. The resistant seed fraction in blends may serve as a trap crop in which the nematodes enter but fail to mature. Blends may also help curb development of still newer races of pests, a problem whenever pests are continuously exposed to resistant plants.

Harvest Losses Ever since soybean production has become a viable industry it has been beset by significant harvest losses. A 1927 University of Illinois study showed that these losses exacted 11.7 percent of the State's crop yield. Today's losses in major soybean-producing States average 8 to 10 percent of the yield.

Agricultural engineer W. Ralph Nave is studying design needs for soybean harvesting and handling equipment, including use of high-speed photography to isolate causes of harvesting losses. His design work on combines employing compressed air and floating cutterbars looks promising. In other research, he found that many farmers could reduce losses by 1 or 2 bushels per acre through proper adjustment of contemporary combines.

Advances in the Federal-State cooperative research will provide the know-how for the Nation's farmers in achieving higher soybean yields on about 50 million acres already devoted to the crop, nearly 30 percent of which is exported. These advances will help the industry maintain a steady and growing market and meet world demands for soybeans. □

Right: Soybeans planted in 7-inch rows and not cultivated may be one way to increase production; current research suggests a 10 to 15 percent yield advantage over conventional 30-inch rows. The key to success will hinge on a satisfactory weed control system. Researchers Cooper, Nave, and Wax compare the two row spacings (0973X1462-5).

Dr. Radha examines leaf infection in a young coconut palm. Early symptoms are found on the young developing fronds, such as the dark sunken spots shown here. These spots indicate infection by P. palmivora. *The fronds turn a light greyish brown which becomes darker as they bend over and collapse at the base. Infection spreads inward to the soft tender bud tissue (PN–2846).*

Early warning forecast for coconut bud rot

Wing down Florida's west coast from Punta Gorda to Naples; criss-cross to the east coast and fly from Palm Beach County to the Keys: one can see 90 percent or more of the coconut palms of that State—over 1 million trees. All are possible candidates for Phytophthora bud rot, a fungal disease caused by *Phytophthora palmivora* that attacks the terminal bud. If the bud dies, the tree dies.

This usually incurable disease, which is widespread in coconut-producing regions of the world, has been reported on Washington palm in Arizona; also in Florida where there have been significant, localized outbreaks. *P. Palmivora* attacks coconut palm, Queen's, Cuban Royal, and Sabal Palmetto—commercially important ornamentals grown in Florida. Control of this disease would not only help protect U.S. ornamental palms, but would also benefit U.S. industry which in 1972 imported 230,357 short tons of copra and 338,485 short tons of coconut oil.

ARS-sponsored research in India, an important coconut-producing country, has been aimed not at curing, but preventing the disease through an early warning system to detect specific trees or areas with potential bud rot susceptibility. This warning system utilizes microclimate and susceptibility data for devising a model for selective control.

Under the direction of principal investigator, Dr. K. Radha, Indian scientists isolated the causal agent of bud rot in India, developed a laboratory method for obtaining inoculum, mastered a technique to inoculate young plants for resistance, and screened fungicides for effectiveness.

Indian investigators found that greatest susceptibility occurs in young trees 5 to 10 years old. The disease organism is spread by moisture-laden wind. In progressive stages as the trees grow taller (heights of 90 to 100 feet in *Cocos nucifera* at maturity), the microclimate of the bud becomes less favorable for development of disease.

From microclimate data involving the bud and the fronds surrounding it, Dr. Radha determined that excessive humidity provides the ideal environment for sporulation. Dr. Radha's solution, which proved workable in India, is to treat the susceptible young trees before the spores land on host targets, thereby preventing fungal germination. Of the fungicides tested, Bordeaux mixture was confirmed as most effective.

Because of costs, however, the thousands of young trees on U.S. and foreign plantations cannot be individually treated. If coconut-producing regions are to benefit from pinpoint disease prevention, future research will have to apply the Indian microclimate data to determine the precise environmental conditions that will prevent development of bud rot.

This Indian research was conducted under the provisions of Public Law 480 at the Central Coconut Research Station, Kerala. ARS-cooperating scientists were Dr. Joseph H. Graham, Beltsville, Md., and Dr. Charles Wilson, Delaware, Ohio. □

Putting back the green

THREE YEARS of research on the revegetation of strip mine spoils in the Northern Great Plains have revealed no easy solutions.

Reclamation of strip mined lands is becoming more important in the Northern Plains because lignite production is expected to increase due to the increased demand for low sulfur coal. North Dakota and Montana, with 44 percent of known reserves, lead the Nation in lignite. Estimates of strippable lignite reserves in the two States range from about 15 to 37 billion tons. With current mining techniques, that could eventually result in about 1.5 million acres of strip mine spoils in the two States.

The key problem to revegetation of strip-mined lands is the combination of very fine textured materials and high sodium levels. The content of fine material or clay is often greater than 40 percent and is not of itself a severe problem. Coupled with the high sodium level, however, the problem becomes more acute.

Highly sodic soils are practically impermeable to water. When sodic soils are wetted, sodium causes soil aggregates to swell and disperse. The resulting smaller particles fill the pores or openings in the soil, creating a barrier to the easy entry of water. Soil tests show that both clay and sodium content increase with depth. Since typical stripping procedures leave material from the bottom of the stripped trench on the surface, developing revegetation methods is critical to recovery of the land.

Soil scientists Fred M. Sandoval, Jack J. Bond, James F. Power, and Wayne O. Willis of the Northern Great Plains Research Center, Mandan, N. Dak., conducted studies to determine the chemical and physical properties of these spoil materials. They then treated various plots with topsoil, straw, gypsum, and sulfur, singly and in combinations. Various fertilizer treatments were also applied. Native grasses were seeded on some plots and barley on others. The crops were clipped and dry matter was measured.

The most successful treatment included 2 inches of topsoil (about 300 tons), 10 tons of gypsum, and 3 tons of straw, along with 200 pounds of 10-10-10 commercial fertilizer per acre. Only one rate of topsoil and gypsum was tested. The fertilizer tests showed phosphorus to be especially important. Plants on plots without phosporous fertilizer showed very severe phosphorous deficiency symptoms. Plant growth in response to the best treatment was only 25 to 35 percent of what one would expect for unmined soil, however.

The plots will be maintained for several years to observe leaching under natural conditions in order to evaluate the sodium problem. Calcium from gypsum should eventually replace the spoil sodium, thus freeing the sodium to leach below the root zone. Replacement of sodium with calcium should improve water penetration and permit leaching of the replaced sodium. ☐

Above: *This is a typical North Dakota strip mining operation (0673W1236–22).* ***Left:*** *Dr. Sandoval observes grass grown on test plot treated with 2 inches of top soil (0673W1235–3).*

The healthy disease carrier

SEEMINGLY healthy swine that are carriers of erysipelas probably are the chief cause of sudden, unexplained outbreaks of the disease.

The role of these carriers as disseminators of erysipelas has been partially clarified in studies by ARS veterinary medical officer Richard L. Wood. Previously, carrier animals were known to harbor the causative agent, the bacterium *Erysipelothrix rhusiopathiae,* in their tonsils and other lymphoid tissue. But their importance in dissemination of infection was not established.

A commonly held belief, though not supported by research evidence, has been that the organism is capable of long-term survival in hoglot soil. "The organism is considered to live in the soil as a saprophyte," the 1956 YEARBOOK OF AGRICULTURE noted, "and can multiply under favorable conditions of moisture and in soil rich in humus . . . Perhaps it has always been present as a soil organism."

Working at the National Animal Disease Laboratory, Ames, Iowa, Dr. Wood initiated his investigation on how swine erysipelas is perpetuated by asking, "Can the organism be found in soil and manure on swine-raising premises?"

The answer was "yes," whether or not there had been a recent outbreak of the acute form of the disease. Dr. Wood isolated *E. rhusiopathiae* from 38 percent of samples from Iowa farms with no recent history of swine erysipelas. He also found the organism in 26 percent of the samples where recent outbreaks had been reported by practising veterinarians and had been confirmed by the Veterinary Diagnostic Laboratory at Iowa State University, Ames. Ninety-five percent of the isolates from all the farms were pathogenic for swine.

Dr. Wood collected soil and manure samples one to three times between May and October, beginning 6 to 101 days after the disease had been reported on 11 farms. He also collected samples on eight farms with no record of acute swine erysipelas in at least 5 years, and in most cases not within the memory of the operator. Isolates of *E. rhusiopathiae* that were proven pathogenic for swine were obtained from all farms without recent history of the disease and from 10 to 11 farms where acute outbreaks had occurred.

Results of this study prompted a second question: "How long does *E. rhusiopathiae* survive in soil?"

Contrary to the commonly held view, Dr. Wood found no evidence of growth or maintenance of *E. rhusiopathiae* populations after they were added to experimental soils. The organism died out in soil at a logarithmic rate under all tested conditions of temperature, moisture content, acidity or alkalinity (pH), and organic matter content.

Temperature exerted the most marked effect on viability. Survival times varied from 52 hours at 86° F. to as long as 35 days at 32° F. At 53° F., survival time was 4 days in partially air-dried soil and 14 days in moist or saturated soil, 7 to 18 days at various ranges of pH, 7 days in laboratory-prepared soil high in organic matter content, and 11 to 16 days in hoglot soils. Dr. Wood concluded that, at least in the baccillary form found in animals and grown on artificial medium, *E. rhusiopathiae* survives poorly in soil.

If the organism is detected frequently in hoglot soils, even in the absence of acute cases of the disease, but survival in soil is poor, Dr. Wood reasoned that the disease must be perpetuated by apparently healthy carrier animals. This prompted research to answer the question: "Can *E. rhusiopathiae* be found in feces of apparently healthy swine where the organism has been found in the soil?"

Dr. Wood returned to four farms involved in the first study—farms where swine had been raised 15 years or longer without an acute case of swine erysipelas. He collected more than 600 samples of fresh feces from sows and 3- to 6-month-old pigs on these farms as well as samples of hoglot soils.

Sixteen samples of feces—2.63 percent of the total—contained isolates of *E. rhusiopathiae* that proved pathogenic when injected into specific-pathogen-free pigs. The organism was detected in feces samples from all four farms, from both sows and pigs, and in one or more soil samples from each farm.

If 2.63 percent of the total fecal output of apparently healthy swine contains the organism, Dr. Wood estimates that about 11½ pounds of scattered droppings containing *E. rhusiopathiae* could be produced daily by a herd of 400 swine. "It is possible," he concludes, "that this quantity of contaminated feces applied to the relatively confined area of hoglots could provide continual inoculation of the soil at a rate sufficient to establish the importance of healthy carrier swine in the dissemination of *E. rhusiopathiae*."

Increased knowledge of the occurrence of the causative agent outside the animal host may now lead to more effective control of swine erysipelas. □

Aerial spraying of foam plus fungicide on a sugarbeet field in Ohio controls Cercospora leafspot disease (PN–2847).

FOAM FIGHTS PLANT DISEASES

FOAM APPLICATION of fungicides may be as effective in controlling plant diseases as conventional spraying, with less chance of harm to the environment.

In tests on a farm at Old Fort, Ohio, the addition of a commercial foaming agent to the fungicide substantially reduced lateral spray drift during aerial application. Other potential advantages of foam application include deposition of a greater proportion of the fungicide on plant leaves, uniform suspension of the material, and treatment on days when wind prevents spraying by conventional methods.

Plant pathologists Charles L. Schneider of ARS and Howard S. Potter of the Michigan Agricultural Experiment Station, East Lansing, compared foam and spray application for control of leafspot disease on sugar beets. Both methods increased the root weight of sugar beets by 25 percent and the content of gross sugar by 28 percent in comparison with an untreated control.

The plant pathologists obtained equally effective disease control with benomyl, a systemic fungicide, and triphenyltin hydroxide, a nonsystemic. Both materials are Federally registered for use on sugar beets. Plots ⅓-mile long and 105-feet wide were treated twice—once when disease symptoms were first noticed and again 3 weeks later.

In a second experiment at East Lansing, the researchers compared foam and spray applications of benomyl on plots artificially infested with leafspot. Again, foaming controlled the disease as effectively as conventional spraying. In this test, the researchers used a hand-operated sprayer for three fungicide treatments at 21-day intervals on two 60-foot rows of beets.

Another study by Dr. Potter demonstrated that foam application of systemic or surface-protecting fungicides would control late blight of celery. These are the first reported studies using foam in applying fungicides. Foam has previously been used in applying herbicides and insecticides on other crops and for protecting winter vegetables from frost damage.

In continuing studies, Dr. Schneider and Dr. Potter are seeking ways to take advantage of the more precise application of fungicides when foam is added. Ability to concentrate the material at the crown of the sugar beet plant with a ground sprayer may give more effective control of crown and root rot of beets, since the disease organism appears to enter the plant at the crown. The possibility of reducing the amount of fungicide needed for control of sugar beet disease will also be explored. □

Technician Robert L. Sims (foreground) assists Dr. Schneider and Dr. Porter in testing foam application with a small experimental-type sprayer in the greenhouse (PN–2848).

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